

American Museum Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y. 10024

NUMBER 2454

FEBRUARY 26, 1971

Results of the Archbold Expeditions. No. 94 Taxonomic Status of *Rattus tatei* and *Rattus frosti*, Two Taxa of Murid Rodents Known from Middle Celebes

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At the end of his classification of the genus *Rattus*, published in 1941, John R. Ellerman reported on a large collection of murid rodents from Celebes that had been obtained by W. J. C. Frost during the winter of 1938. Seventeen taxa were represented in Frost's material; nine were new to the collections of the British Museum (Natural History), and three were named and described by Ellerman: *Rattus tatei*, *R. frosti*, and *R. hellwaldii dollmani*. From 1941 no additional specimens of these three forms were reported in the mammalogical literature until 1969 when I documented other specimens of *dollmani* and showed that the taxon represented a valid species rather than a subspecies of *R. hellwaldii* (Musser, 1969b). The identities and allocations of *R. tatei* and *R. frosti* have been obscure since the names were first proposed by Ellerman, and from that time to the present each taxon has been differently allocated by workers who have published taxonomic information on murids of Celebes (Laurie and Hill, 1954; Schwarz and Schwarz, 1967; Misonne, 1969).

In the fall of 1969 I visited the British Museum (Natural History) and studied the murid rodents obtained from Celebes by Frost, including the

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holotypes of *Rattus tatei* and *R. frosti*. I found that each taxon is based upon young individuals. The type specimens of *R. tatei* are young examples of *R. hoffmanni* and the type series of *R. frosti* consists of young individuals of *R. dominator*. The evidence for these conclusions is documented below.

ABBREVIATIONS AND METHODS

The specimens discussed in the present paper are in the collections of the British Museum (Natural History) (B.M.) and the National Museum of Natural History of the Smithsonian Institution (U.S.N.M.).

Measurements of the length of head, body, and tail are those of the collectors and were taken from labels attached to study skins. I measured the length of hind foot of all specimens from study skins. Cranial measurements were taken with Anderson's craniometer (Anderson, 1968) and with dial calipers graduated to tenths of millimeters. The limits of most of these measurements are explained elsewhere (Musser, 1970a). The greatest length and the greatest breadth of each tooth was measured with the calipers under a dissecting microscope.

TAXONOMIC IDENTITIES AND ALLOCATIONS OF *RATTUS TATEI* AND *R. FROSTI*

The type series of both *Rattus tatei* and *R. frosti* were collected by Frost at Tamalanti, middle Celebes, from an elevation of 3300 feet. I have not been able to locate Tamalanti on maps of Celebes available to me. In the gazetteer published in their list of land mammals of New Guinea and Celebes, Laurie and Hill recorded the locality as a "Plantation between Rantekaroa and Koelawi," (1954, p. 156). *Rattus tatei* is based upon the holotype (B.M. No. 40.603) and another individual (B.M. No. 40.604) collected November 1 and 2, 1938. *Rattus frosti* was named and described from two specimens (B.M. Nos. 40.494 and 40.495) that were obtained November 4 and 5.

IDENTITY AND ALLOCATION OF *Rattus tatei*

Ellerman described *Rattus tatei* as (1941, p. 215): "Skull with all the main characters of the *rattus* or *concolor* group; supraorbital ridges relatively weaker than usual in the two specimens examined; braincase very broad; zygomatic plate moderately projected forwards, not very strong. Palate long, extending slightly behind last molars. Bullae large, about 18 per cent of occipitonasal length. Palatal foramina long, extending between front molars. Molars excessively heavy, length of toothrow about

20.12 per cent of condylobasal length; greatest breadth of molars over 2 mm. M_3 relatively large, but pattern of molars not abnormal. Head and body length, 130 mm. Fur soft; above dark brown, below grey. Tail slightly longer than head and body in the type specimen, slightly shorter in the other specimen, No. 215. The tail has 11–13 rings to the centimeter on the upper part, and is uniformly dark throughout. Hind foot rather long, but broad, and with long fifth digit, as usual in *rattus* or *concolor* group.”

Ellerman also stated that “The species seems clearly differentiated from all members seen of the Celebes *rattus* group (of which it could be a dwarf member) by its much smaller size, and from the *concolor* group by its unusually wide, heavy teeth, and longer toothrow.”

In his revised classifications of the genus *Rattus*, published in 1947 and 1949, Ellerman listed *R. tatei* as a species in the subgenus *Rattus*, and implied that it could be referred to the *rattus*-group of species within that subgenus (1949, pp. 49–50). Later authors, however, have treated the name differently. Laurie and Hill listed *R. tatei* at the end of their section on *R. exulans* (1954, p. 106). Schwarz and Schwarz, in their monograph of *Rattus rattus* (1965, p. 133), regarded the name *tatei* as a synonym of *R. rattus mindanensis*, a form originally named and described by Mearns (1905) and based upon specimens from Mount Apo, Mindanao, in the Philippine Islands. In explaining this action, they commented that “the type of *tatei* is obviously a young animal. It has nothing to do with *concolor*; the skull measurements given by Ellerman (1941) are practically identical with those of skulls of *mindanensis* of comparable age before us. The length of the toothrow is perfectly characteristic” (p. 134). Finally, Misonne (1969, p. 137) indicated that *R. tatei* probably belonged in the subgenus *Stenomys*, but he gave no reasons for this allocation.

Schwarz and Schwarz were correct in pointing out that the holotype of *R. tatei* is a young animal and that the species is not closely related to *concolor*, a taxon that is presently listed as a subspecies of *R. exulans* (Ellerman, 1949), but they were incorrect in considering *tatei* to be a synonym of *R. r. mindanensis*. The holotype of *R. tatei*, as well as the other specimen on which Ellerman based the name, are not examples of either *R. exulans* or *R. r. mindanensis*, and the taxon is not closely related to any species now placed within the subgenus *Stenomys*. Instead, both specimens of *R. tatei* represent *R. hoffmanni*, a species known only from the mainland of Celebes and some offshore islands.

In addition to the two examples of *R. tatei*, Frost collected examples of other species of *Rattus* at Tamalanti. Among these were two individuals that Ellerman later identified as *R. hoffmanni*. Both were obtained at

3300 feet on November 4 and 6. The oldest, B.M. No. 40.554, is in full adult pelage. It is a female, the teeth are worn down to the tops of their roots. The other specimen, B.M. No. 40.553, is an adult male. It is younger than the female; all cusps are worn, but not so that their enamel patterns are obliterated.

The two examples of *R. tatei* are very young females, but are in adult pelage. The holotype, B.M. No. 40.603, is slightly larger and judged by wear of its teeth probably older than the other specimen, B.M. No. 40.604. The configurations and proportions of various parts of the crania of both specimens are characteristic of young animals. For example, the dorsolateral ridges bounding the supraorbital, frontal, and parietal regions are low and barely perceptible. Sutures between many of the bones are either open or partly closed. There is little wear on any of the cusps in B.M. No. 40.604. The teeth of the holotype are more worn, but less than what would be expected in older individuals. The morphological differences between these two specimens, and the two examples of *R. hoffmanni* from Tamalanti are due primarily to age; comparable ranges in age occur in many samples of *R. hoffmanni*, including samples from middle Celebes.

Two forms of *Rattus hoffmanni* from middle Celebes have been described, *R. h. subditivus* and *R. h. linduensis* (Miller and Hollister, 1921a, p. 70). Specimens that formed the basis of *subditivus* are not examples of *R. hoffmanni* but represent *R. nitidus*, a species that occurs throughout the Asian mainland from India to China, and one that also has been found on northern Luzon in the Philippine Islands, and on Ceram. I document the identity of *subditivus*, as well as the occurrence of *R. nitidus* on Celebes and other regions outside of the Asian mainland, in a report now being prepared.

The taxon, *linduensis*, is a distinctive subspecies of *R. hoffmanni*. It was originally known from 49 specimens collected by Raven from Bumbaroedjaba, Koelaw, Lebio, Pinedapa, Rano Rano, Tomado, and Lake Lindoe, all localities in middle Celebes. I have examined these specimens, including the holotype, U.S.N.M. No. 218700, from Tomado, Lake Lindoe. Seventeen of the 49 specimens were collected from Rano Rano and this is the largest series of *R. h. linduensis* that was obtained from a single locality, and the best sample with which to study age and individual variation. External and cranial measurements of the 17 specimens are listed in tables 1 and 2 and compared there with measurements of two adults of *R. hoffmanni* from Tamalanti and the two examples of *R. tatei*.

The series from Rano Rano is arranged in the tables according to age

EXTERNAL MEASUREMENTS (IN MILLIMETERS) FROM SPECIMENS OF *Rattus hoffmanni* AND *Rattus tatei* FROM MIDDLE CELEBES

Taxon, Locality, Specimen	Age	Sex	Head and Body Length	Tail Length	Hind Foot Length	Scale Rows of Tail (per cm.)
<i>R. hoffmanni</i> , Rano Rano						
U.S.N.M. No.						
219618	Adult	M	—	—	—	—
219614	Adult	M	175	177	39	12
219590	Adult	M	180	185	40	9
219583	Adult	M	175	180	40	10
219577	Adult	F	165	—	38	—
219578	Adult	F	180	180	40	11
219586	Adult	F	174	172	38	10
219621	Adult	M	—	—	—	—
219588	Adult	F	165	155	37	11
219617	Adult	F	168	175	40	11
219579	Young Adult	F	129	129	35	14
219634	Young Adult	F	140	130	35	14
219623	Young Adult	M	137	125	33	14
219585	Young Adult	M	140	130	33	15
219632	Young Adult	M	130	125	32	15
219633	Juvenile	F	120	120	33	15
219576	Juvenile	F	111	110	28	17
<i>R. hoffmanni</i> , Tamalanti						
B.M. No.						
40.554	Adult	F	185	175	36	11
40.553	Adult	M	175	150	36	10
<i>R. tatei</i> , Tamalanti						
B.M. No.						
40.603 ^a	Young Adult	F	130	140	33	12
40.604	Young Adult	F	130	125	32	13

^a Holotype.

TABLE 2
CRANIAL MEASUREMENTS (IN MILLIMETERS) FROM SPECIMENS OF *Rattus hoffmanni* AND *Rattus latzi* FROM MIDDLE CELEBES

Taxon, Locality, Specimen	Breadth		Skull (Greatest Length)	Length					M ¹⁻³ (Alveolar)	Bulla	
	Zygomatic	Interorbital		M ¹	Nasals	Rostrum	Palatal Bridge	Incisive Foramina			Diastema
<i>R. hoffmanni</i> , Rano Rano											
U.S.N.M. No.											
219618	21.6	5.8	—	16.8	13.3	9.1	8.2	11.5	24.4	7.9	7.3
219614	20.3	6.4	42.9	16.5	13.9	8.5	7.9	11.6	23.2	7.6	7.6
219590	20.7	6.2	43.7	17.3	14.2	8.5	8.1	11.6	23.4	7.8	7.1
219583	20.4	6.1	42.9	15.9	13.3	8.5	8.0	11.7	23.5	7.5	7.3
219577	20.4	6.2	45.0	17.8	14.8	8.6	8.3	12.4	24.1	7.6	7.2
219578	20.3	5.9	—	16.5	13.7	8.5	8.1	11.9	23.4	7.9	7.2
219586	—	6.2	40.8	15.4	12.8	8.3	7.8	11.0	22.7	7.7	7.2
219621	19.3	5.9	—	16.1	13.0	8.5	7.6	11.2	22.8	7.5	7.2
219588	19.6	5.9	41.2	15.8	12.7	7.9	7.7	10.2	21.5	7.8	7.1
219617	—	5.6	—	15.2	12.8	7.9	7.5	10.8	21.8	7.5	—
219579	—	—	—	—	—	—	—	—	—	7.6	6.3
219634	—	—	—	12.7	10.6	7.4	6.6	9.1	19.5	6.4	—
219623	17.7	5.4	34.6	11.9	10.2	7.0	6.3	8.2	18.4	6.9	6.2
219585	—	5.2	—	—	—	6.5	6.1	8.0	17.6	7.0	—
219632	16.9	5.2	34.8	12.4	10.3	7.2	6.5	8.2	18.9	7.1	5.9
219633	—	5.3	—	12.3	10.4	6.9	6.8	8.4	18.8	7.5	6.0
219576	—	5.2	30.9	10.4	9.0	6.1	5.9	7.2	16.7	7.0	5.7
<i>R. hoffmanni</i> , Tamalanti											
B.M. No.											
40.554	21.6	5.7	—	—	—	8.6	8.1	12.0	23.7	8.1	7.2
40.553	20.3	6.1	41.4	16.0	12.6	8.1	8.0	10.4	22.4	8.2	7.0
<i>R. latzi</i> , Tamalanti											
B.M. No.											
40.603 ^a	—	5.5	36.7	13.6	11.0	7.5	6.5	8.7	19.4	8.1	6.5
40.604	—	5.2	34.9	12.5	10.2	6.9	6.6	8.5	18.5	7.4	6.2

^a Holotype

as estimated by wear of teeth, cranial configuration, size, and pelage. Ten of the specimens are adults. Of these, U.S.N.M. Nos. 219618 and 219614 are the oldest; the teeth of both specimens are worn almost to the roots, but not so that the enamel pattern formed by the cusps are obliterated. External and cranial dimensions, cranial configurations, and probably ages of the two specimens of *R. hoffmanni* from Tamalanti fall within the range of variation of the 10 adults from Rano Rano (tables 1 and 2). In fact, B.M. No. 40.553, the younger of the two from Tamalanti, is closely similar to U.S.N.M. No. 219583; the crania of both specimens are compared in figure 1.

Five other specimens from Rano Rano are in adult pelage, but each is smaller and obviously younger than any of the 10 adults discussed above. Of the five, U.S.N.M. No. 219579 is the oldest and U.S.N.M. No. 219632 is the youngest. All five differ conspicuously from the 10 older adults in the series from Rano Rano. The bodies and tails of the young adults are shorter; there are more scale rows on the tails; the crania are smaller in almost every dimension that was measured; the crania do not have the ridging and rugosities characteristic of older specimens; and the teeth are only slightly worn. The range of variation in external and cranial features of these five young adults encompasses the variation seen in the two specimens of *R. tatei*. Of the five specimens from Rano Rano, U.S.N.M. No. 219632 is similar to B.M. No. 40.604 in size of external and cranial dimensions, pelage, cranial configuration, wear of teeth, and probably age. The skulls of both individuals are compared in figure 1.

The next youngest specimen in the series from Rano Rano is U.S.N.M. No. 219633. The animal was molting when it was captured. Adult pelage has replaced juvenal pelage along the sides of the head and body and is coming in over the back. It has not completely replaced the juvenal pelage which still persists along a middorsal strip that extends from head to rump.

The youngest specimen in the series from Rano Rano is U.S.N.M. No. 219576. This individual is in full juvenal pelage and is much smaller than any other specimen in the series.

The magnitude of variation in age in the series from Rano Rano is similar to the range of variation observed in other large series of *R. hoffmanni* that I have examined and measured from northeastern Celebes. The only difference is that the larger samples of *R. hoffmanni* consist of an age spectrum that ranges from old adults to juveniles; these samples do not contain discrete age groups as does the series from Rano Rano.

That sample can be separated into discrete adult and young adult groups, but not into discrete groups of young adults and juveniles.

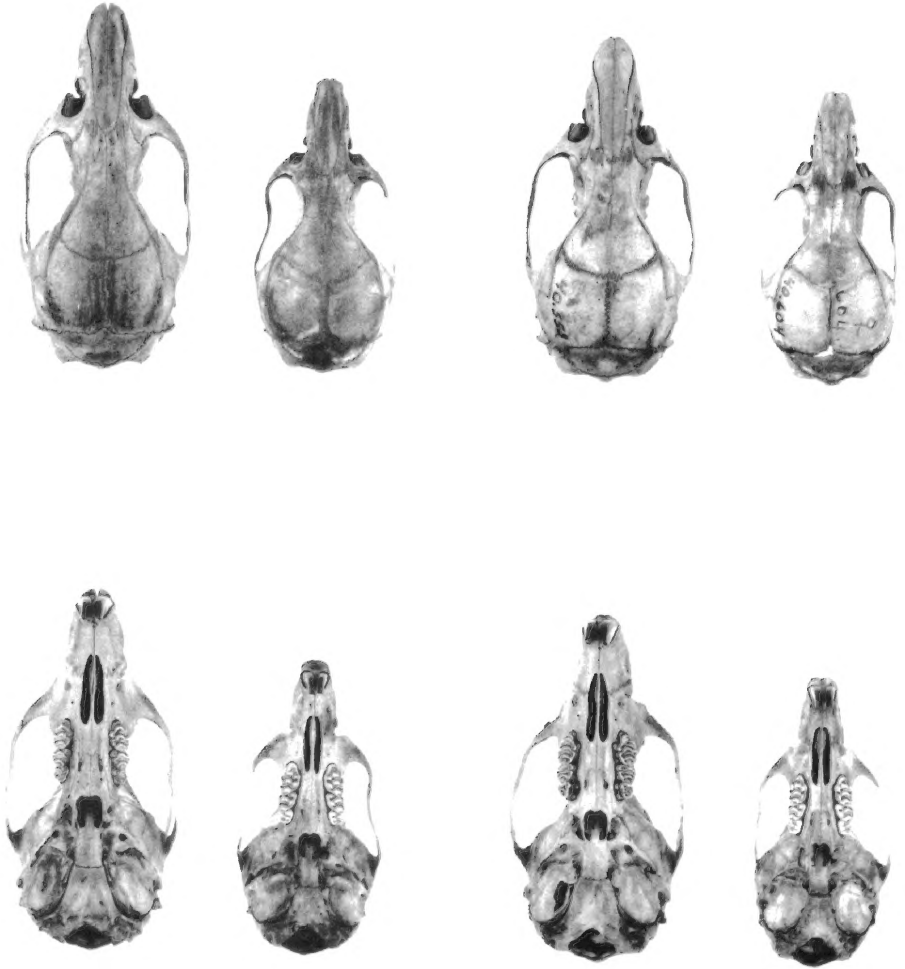


FIG. 1. Dorsal (top) and ventral (bottom) views of crania. From left to right: adult (U.S.N.M. No. 219583) and young adult (U.S.N.M. No. 219632) *Rattus hoffmanni linduensis*, Rano Rano, middle Celebes; one (B.M. No. 40.553) of the two adults from Tamalanti that John R. Ellerman identified as *R. hoffmanni*; and one (B.M. No. 40.604) of the two young adults from Tamalanti that Ellerman designated as *R. tatei*. All natural size.

The two examples of *R. tatei* are clearly young *R. hoffmanni*. Some of the characters that Ellerman described and thought were diagnostic for *R. tatei*—namely, small size, weak supraorbital ridges, short tail, large number of scale rows on the tail, and soft pelage—are features characteristic of young individuals of *R. hoffmanni*. Furthermore, Ellerman also

stated that the first upper molars of *R. tatei* were long and wide. Wide teeth are a diagnostic feature of *R. hoffmanni*. For example, the breadth of the first upper molar exceeds 2.0 mm. in that species (table 2); this dimension is rarely greater than 1.9 mm. in specimens of *R. rattus* from the mainland of Celebes, and usually less than 1.6 mm. in examples of *R. exulans* from that region.

On the basis of external and cranial features, as well as geography, the two specimens of *R. hoffmanni* from Tamalanti and the two examples of *R. tatei* represent the same taxon; the name, *Rattus tatei* Ellerman, 1941, is a subjective synonym of *Rattus hoffmanni linduensis* Miller and Hollister, 1921a.

IDENTITY AND ALLOCATION OF *Rattus frosti*

The description of *Rattus frosti* was given by Ellerman as (1941, p. 216): "A member of the *xanthurus* group probably most nearly allied to *celebensis*. Palatel foramina abnormally shortened, only 51 per cent of diastema. Upper toothrow long, about 19.4 per cent of condylobasal length. Bullae about 13.5 per cent of occipitonasal length. Skull with moderately weak supraorbital ridges; braincase rather broad; upper profile of skull differing from a specimen of *celebensis* from Tonsea, North Celebes, in the weaker supraorbital ridges, wider interorbital region, wider braincase, and shorter interparietal. Zygomatic plate scarcely projected forwards anteriorly. Upper incisors more opisthodont than in *celebensis*, reminiscent of those of *dominator*. Palatel foramina extremely shortened, but not peculiar in form. Palate of moderate width, extending posteriorly about to level of hinder part of third molars. Bullae moderately large and evenly inflated. Molars heavy; M_3 not much reduced. Clear traces present of the fourth inner cusp on the second lamina of M_1 and M_2 as characteristic of *R. hellwaldi*.

"Fur thicker than is usual in *celebensis*, but not excessively so. Hindfoot apparently with six plantar pads, the foot broad and heavy, as is usual in the group, very different from the narrow specialized formation of *chrysocomus*, *musschenbroeki*, or *hellwaldi* groups. Tail rings about 11 to the centimeter on the upper part; the tail wholly black for just over a third of its length basally, white for the rest of its length except the terminal 55 mm. on which the white marking is less apparent. Under surface of body and limbs white. Above grey." Ellerman listed external and cranial measurements of the holotype, then stated: "This species is differentiated from *celebensis* by its relatively longer toothrow and shorter palatal foramina; the only other species of the group, from descriptions, with such unusually short palatal foramina seems to be *microbullatus*, which according

to descriptions seems to present many features reminiscent of *dominator*, and may belong with that species."

In addition to the holotype, B.M. No. 40.494, Ellerman also assigned another specimen from Tamalanti, B.M. No. 40.495, to *R. frosti*. Furthermore, he indicated that two specimens obtained from Rantekaroa, Quarles Mountains (B.M. No. 40.496 and 40.497), "which are too young for certain identification, also appear to belong here."

Although Ellerman initially compared *R. frosti* with *R. celebensis* in the original description, he associated *R. frosti* more closely with *R. dominator* in later publications. In a preliminary report on revisions which were to appear in volume three of "The Families and Genera of Living Rodents," Ellerman listed *R. frosti* after *R. dominator* and included them within the subgenus *Stenomys* (1947, p. 264). At that time he placed *R. celebensis* in the subgenus *Rattus*. In his revised classifications of the genus *Rattus* which appeared in volume three, Ellerman again listed *R. dominator* and *R. frosti* close together within the subgenus *Stenomys*; these two were the only species in his "*dominator* group." Ellerman thought that "*frosti* is near *dominator*, but is smaller, and occurs with it" (1949, p. 51). In 1954, Laurie and Hill listed *R. frosti* along with *R. dominator* and *R. microbullatus*, under the subgenus *Paruromys*, a taxon proposed for *R. dominator* and its allies by Ellerman (in Laurie and Hill, 1954, p. 117).

Ellerman correctly assessed the affinities of *R. frosti*; the specimens representing that taxon are morphologically closer to *R. dominator* than to any other species of *Rattus* known from middle Celebes. In addition to the two examples of *R. frosti*, Frost collected seven specimens (B.M. Nos. 40.485-40.491) of a large-bodied rat at Tamalanti from the same elevation as the two specimens of *R. frosti* and at the same time. Ellerman correctly identified these seven individuals as *R. dominator*. All are either adults or young adults. The two specimens of *R. frosti* from Tamalanti are juveniles. The two series actually represent the same species—*R. dominator*.

External and cranial measurements of six of the seven examples of *R. dominator* from Tamalanti are listed in tables 3 and 4. They are compared with measurements of the two specimens of *R. frosti* from Tamalanti and the two juveniles from Rantekaroa, Quarles Mountains, that Ellerman assigned to *R. frosti*. The two oldest individuals in the series of *R. dominator* from Tamalanti are B.M. Nos. 40.486 and 40.485. Both are adults in full adult pelage. Their teeth are well worn, but not so that the enamel patterns are obliterated. The other four specimens, B.M. Nos. 40.487-40.490, are young adults; they are smaller and younger than the two adults, but all four are in adult pelage.

TABLE 3
EXTERNAL MEASUREMENTS (IN MILLIMETERS) FROM SPECIMENS OF *Rattus dominator* AND *Rattus frosti* FROM MIDDLE CELEBES

Taxon, Locality, Specimen	Age	Sex	Head and Body Length	Tail Length	Hind Foot Length	Scale Rows of Tail (per cm.)
<i>R. dominator</i> , Timalanti						
B.M. No.						
40.486	Adult	F	260	310	52	8
40.485	Adult	M	230	300	53	8
40.488	Young Adult	F	220	260	52	9
40.487	Young Adult	M	230	280	51	9
40.489	Young Adult	F	210	250	50	9
40.490	Young Adult	F	210	260	50	10
<i>R. frosti</i> , Timalanti						
B.M. No.						
40.495	Juvenile	F	195	240	50	9
40.494 ^a	Juvenile	F	185	220	47	11
<i>R. frosti</i> , Rantekaroa						
B.M. No.						
40.496	Juvenile	F	140	180	40	13
40.497	Juvenile	F	140	175	40	14
<i>R. dominator</i> , Pinedapa						
U.S.N.M. No.						
219566 ^b	Adult	M	235	257	52	9
219728	Adult	?	—	—	—	—
219564	Adult	M	230	285	53	9
219557	Young Adult	M	220	302	51	9
219548	Young Adult	M	225	295	51	9
<i>R. dominator</i> , Laboea Sore						
U.S.N.M. No.						
218079	Juvenile	F	200	270	53	9
218080	Juvenile	F	183	240	48	11

^a Holotype.

^b Holotype of *R. d. caninus*.

TABLE 4

CRANIAL MEASUREMENTS (IN MILLIMETERS) FROM SPECIMENS OF *Rattus dominator* AND *Rattus frosti* FROM MIDDLE CELEBES

Taxon, Locality, Specimen	Breadth			Skull (Greatest Length)	Length			M ¹⁻³ (Alveolar)	Bulla		
	Zygomatic	Interorbital	Rostrum		Zygomatic Plate	Nasals	Rostrum			Incisive Foramina	Palatal Bridge
<i>R. dominator</i> , Timalanti											
B.M. No.											
40.486	27.8	7.8	10.5	59.7	23.7	20.5	7.1	15.1	15.3	32.2	7.5
40.485	26.5	8.0	9.5	59.4	23.9	19.9	8.8	14.2	15.7	31.9	6.7
40.488	25.7	7.4	8.7	55.6	22.6	19.3	7.9	13.0	13.7	29.4	7.0
40.487	25.6	7.5	8.7	54.8	22.4	18.0	7.1	13.1	13.5	29.0	6.4
40.489	24.9	7.3	8.7	53.9	20.3	17.5	7.2	12.4	13.2	27.8	6.9
40.490	—	7.0	8.5	53.0	19.7	17.4	6.9	13.2	13.4	27.8	7.1
<i>R. frosti</i> , Timalanti											
B.M. No.											
40.495	23.8	7.2	8.6	51.2	20.2	16.8	6.4	12.0	12.7	26.6	7.1
40.494 ^a	23.7	7.7	8.4	—	16.4	14.6	5.8	12.0	11.6	25.4	6.7
<i>R. frosti</i> , Rantekarao											
B.M. No.											
40.496	—	6.5	7.1	4.1	—	—	5.2	10.3	10.6	22.4	7.1
40.497	—	6.9	7.5	4.1	16.4	13.9	5.4	10.0	10.0	21.9	9.3
<i>R. dominator</i> , Pinedapa											
U.S.N.M. No.											
219566 ^b	27.3	7.5	10.8	59.1	24.7	20.1	8.1	14.0	15.5	32.0	10.3
219728	26.8	7.3	9.7	60.4	24.1	19.9	9.8	12.9	15.9	32.0	10.5
219564	27.0	7.3	10.0	58.0	23.9	18.8	7.9	14.0	15.1	31.1	10.5
219557	25.3	7.1	9.1	56.5	22.8	19.0	7.9	13.2	14.2	29.6	10.0
219548	25.3	7.2	9.0	55.0	22.9	17.6	7.8	12.5	14.6	29.4	9.6
<i>R. dominator</i> , Laboca Sore											
U.S.N.M. No.											
218079	24.9	7.3	8.5	53.1	21.3	17.6	7.1	12.4	13.1	28.4	9.5
218080	—	6.9	7.4	50.0	18.9	16.7	6.8	11.2	12.8	25.9	9.3
											7.3

^a Holotype.^b Holotype of *R. d. camurus*.

The two specimens of *R. frosti* from Tamalanti are next in age. Both are similar in size, probably close to the same age, and both are obviously younger than the six adults of *R. dominator*. Both individuals were molting from juvenal to adult pelage when they were captured. In each, new adult pelage covers the head and body except for a strip of juvenal pelage about an inch wide that begins from the middle of the back behind the shoulders and extends over the back and rump to the base of the tail. New pelage had proliferated through the skin along this strip and can be seen underneath the juvenal pelage. The only difference between the two specimens is that in the holotype of *R. frosti* the adult pelage had replaced the juvenal pelage farther posteriorly along the back.

The two specimens of *R. frosti* from Rantekaroa are the youngest of the lot. Both are in full juvenal pelage, approximately the same size and age, and much younger than the two specimens of *R. frosti* from Tamalanti. The first and second upper and lower molars are fully erupted and the cusps are only slightly worn. The third pair of molars had erupted above the alveolar surface, but may not have broken through the gums when the animals were captured.

Four crania from the series discussed above, representing different ages and taxa, are illustrated in figure 2. The first skull at the left is B.M. No. 40.486, one of the adults from Tamalanti that Ellerman identified as *R. dominator*. Next to it on the right is B.M. No. 40.488, a young adult example of *R. dominator* from Tamalanti. Next to it is B.M. No. 40.495, one of the two specimens of *R. frosti* from Tamalanti. At the far right is B.M. No. 40.496, one of the juveniles from Rantekaroa that Ellerman tentatively identified as *R. frosti*. The differences in size, cranial configuration, and wear of teeth between these four skulls are due primarily to age. The magnitude of morphological differences seen in figure 2 is typical of the variation in cranial morphology between adults and juveniles in samples of *R. dominator* that I have examined from northeastern, middle, southwestern, and southeastern Celebes.

Most specimens of *R. dominator* in collections of museums were obtained from northeastern Celebes. I have examined more than 60 specimens from this region (including the holotype, B.M. No. 97.1.2.24) that are in collections at London, Leiden, and Washington, D.C. These specimens include ages that range from juveniles similar in age to the two specimens from Rantekaroa to adults that resemble those from Tamalanti. There are fewer specimens from other regions in Celebes. Tate (1936, p. 562), for example, recorded small series from southwestern

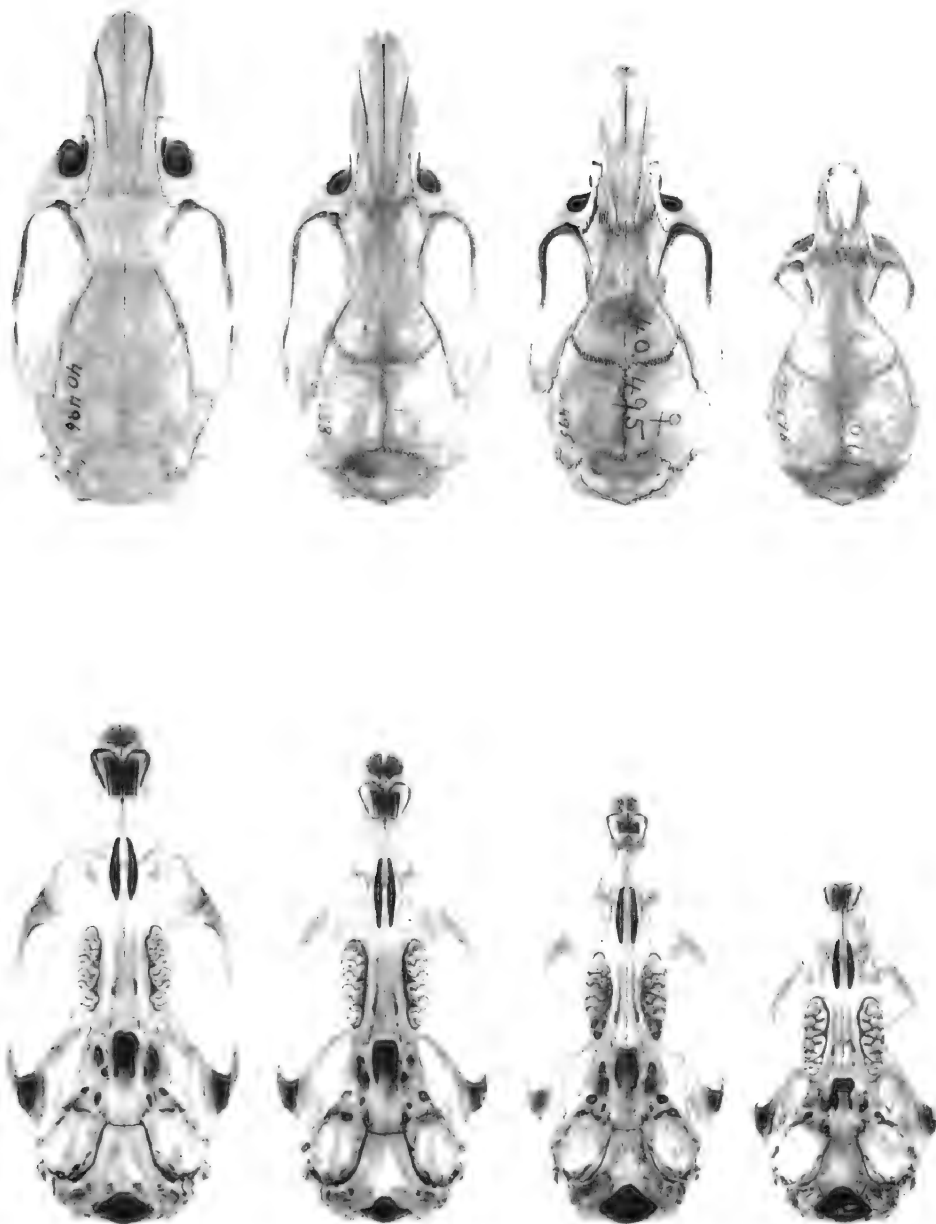


FIG. 2. Dorsal (top) and ventral (bottom) views of crania. From left to right: adult (B.M. No. 40.486) and young adult (B.M. No. 40.488) *Rattus dominator*, Tamalanti, middle Celebes; one (B.M. No. 40.495) of the two specimens from Tamalanti that John R. Ellerman assigned to *R. frosti*; and one (B.M. No. 40.496) of the two juveniles from Rantekaroa, Quarles Mountains, that Ellerman tentatively identified as *R. frosti*. All natural size.

and southeastern Celebes that are in the American Museum of Natural History.

There are only two significant samples from middle Celebes. One is the series collected by Frost. The other consists of specimens obtained by Raven in 1918. Raven obtained five specimens from Pinedapa and two from Laboea Sore in middle Celebes. These specimens formed the basis of *R. dominator camurus*, a subspecies named and described by G. S. Miller, Jr. and Hollister in 1921 (1921b, p. 96). The seven specimens are significant because the ages represented range from juveniles to adults and the magnitude of variation is comparable to that seen between the two specimens of *R. frosti* from Tamalanti and the series of *R. dominator* from that locality. External and cranial measurements of the individuals from Pinedapa and Laboea Sore are listed in tables 3 and 4 where they can be compared with similar measurements for the specimens from Tamalanti and Rantekaroa.

The five specimens of *R. d. camurus* from Pinedapa are all adults. Three (U.S.N.M. Nos. 219556, 219728, and 219564) are similar in size and possibly age to the two adults from Tamalanti. The other two specimens from Pinedapa, U.S.N.M. Nos. 219557 and 219548, are young adults in full adult pelage. Both resemble closely the four young adults from Tamalanti. In fact, the skull of U.S.N.M. No. 219548 is nearly a duplicate of B.M. No. 40.488 in dimensions and configuration.

The two specimens of *R. d. camurus* from Laboea Sore are juveniles and they are older than the two juveniles from Rantekaroa. Their juvenal pelage is worn, faded, and discolored. I could not detect the beginnings of molt in either specimen. In cranial dimensions and configurations, the two specimens are similar to the two examples of *R. frosti* from Tamalanti, although they are probably slightly younger.

The series of *R. dominator* from Tamalanti, Pinedapa, and Laboea Sore, the two specimens of *R. frosti* from Tamalanti, and the two examples from Rantekaroa that Ellerman tentatively identified as *R. frosti* all represent the same species, *R. dominator*. The characteristics of *R. frosti* described by Ellerman—namely, short incisive foramina, long tooth rows, weak supraorbital ridges, opisthodont upper incisors, heavy molars, thick fur, the number of scale rows on the tail, bicoloration of the tail, gray upper parts and white under parts—are features characteristic of young individuals of *R. dominator*. Furthermore, I can detect no significant taxonomic differences between the type specimens of *R. d. camurus* and the sample of *R. dominator* from Tamalanti. In my opinion, *Rattus frosti* Ellerman, 1941, is a subjective synonym of *Rattus dominator camurus* Miller and Hollister, 1921b.

DISCUSSION AND SUMMARY

Present knowledge about the morphological differences due to age in a given population of any species of *Rattus* known from Celebes is derived primarily from study of specimens in collections of museums—specimens comprised of a stuffed skin and an accompanying skull. Actual chronological age cannot be determined with this type of material. The age of one specimen relative to another in the sample can be estimated on the basis of size, type of pelage, relative development of ridging and rugosities on the skull, degree of closure between sutures of various cranial bones, degree of eruption of the molars, and extent of wear of those teeth.

The categories I have used in this report—old adult, adult, young adult, and juvenile—are defined on these characteristics and are merely descriptive, relative terms applied to parts of a given sample. The distinction between adults and juveniles is the most obvious and clear-cut. Because I have no data on reproductive maturation in either *Rattus hoffmanni* or *R. dominator*, I have used “adult” to cover specimens in full adult pelage and “juvenile” to apply to specimens in full juvenal coats and those that are molting from juvenal to adult pelage. I have not been able to detect a subadult pelage in any series of either *R. hoffmanni* or *R. dominator* that are available for study in collections of museums. In small series adult and juveniles can be separated into discrete and easily recognized groups. In larger samples, however, the two groups may be united by specimens that range from those in full juvenal coats, through specimens in stages of molt from juvenal into adult pelage, to specimens that have just completed the molt into adult pelage.

Adults can be divided into very old animals (old adults), those in which the molt from juvenal to adult pelage has just been completed (young adults), and adults of intermediate age. The three categories often form discrete groups in small samples. Large samples, however, may contain the two extremes and a continuous distribution of specimens of intermediate ages. This type of distribution is the exception in series of *Rattus* from Celebes that are available for study, especially samples of *R. hoffmanni* and *R. dominator*. Most samples consist of only adults, only juveniles, or a random assortment of discrete age groups that result from the collecting techniques, amount of time spent in the field, and success of the collector as much as the actual age structure of the population.

Study of small samples of a population that consists of different ages have misled several people besides Ellerman into describing new species of *Rattus* from Celebes on the basis of young individuals of a species that

was already described. For example, Jentink named and described *Mus faberi* in 1883 on the basis of one specimen. That individual was part of a series of rats obtained from Amurang in northeastern Celebes. Five of those other specimens are adults of *Rattus xanthurus*. I recently studied the holotype of *faberi* and found it to be a very young juvenile of *R. xanthurus* (Musser, In press). Jentink separated the small series into two morphological types, but the groups represented different ages rather than different species. Another example is the name *Rattus aspinatus*, a taxon named and described by Tate and Archbold in 1935. The name was based on two of five specimens that had been collected at Ile-Ile in northern Celebes. All five are examples of the same species, *R. mus-schenbroekii*. Three are adult, and the two that formed the type series of *R. aspinatus* are juveniles (Musser, 1969).

The association of the name *R. frosti* with *R. dominator* reduces the number of forms in Ellerman's subgenus *Paruromys* (Laurie and Hill, 1954, p. 117). When that subgenus was proposed, it contained *R. dominator*, *R. frosti*, and *R. microbullatus*. *Rattus frosti* is now a synonym of *R. dominator* and I have shown elsewhere that *R. microbullatus* is a distinctive subspecies of *R. callitrichus*, a species that has no close morphological relationships with *R. dominator* (Musser, 1970b). Thus, if the subgenus *Paruromys* is recognized in future lists (Misonne, 1969, p. 141, however, does not do so; he regarded it as a synonym of the subgenus *Bullimus*) it will contain only *R. dominator*.

Rattus tatei is now a synonym of *R. hoffmanni*. Besides typical *hoffmanni*, Laurie and Hill (1954, p. 104) listed the taxa *linduensis*, *subditivus*, *mengkoka*, *palelae*, *mollicomus*, and *mollicomulus* as subspecies of *R. hoffmanni*, although they were uncertain of the taxonomic status of the last three names. The names *subditivus* and *palelae* do not belong with *R. hoffmanni*. I have examined and measured the holotypes of both taxa; *subditivus* is a synonym of *R. nitidus* and *palelae* is a subspecies of *R. rattus*. Only the names *linduensis*, *mengkoka*, *mollicomus*, and *mollicomulus* can be associated with *R. hoffmanni*. Furthermore, the name *biformatus*, a taxon named and described by Sody in 1941 (p. 306) and based upon specimens from the Togian Islands, applies to a sample of *R. hoffmanni*, a conclusion I reached after examining the holotype at the Rijksmuseum van Natuurlijke Historie in Leiden. I document these observations in a report that is now in preparation.

ACKNOWLEDGMENTS

The present paper is one of a series of taxonomic reports dealing with

identification and allocations of certain murid taxa of Celebes. I could not have completed this paper without the help of Mr. John Edwards Hill of the British Museum (Natural History) in London, and Drs. Charles O. Handley, Jr., Henry W. Setzer, and Richard W. Thorington of the National Museum of Natural History of the Smithsonian Institution, Washington, D.C. Through the unselfish efforts of these persons, I had the opportunity to study specimens in collections under their care. I am grateful to Mr. Robert E. Logan, a staff photographer of the American Museum of Natural History, for the excellent photographs; to Miss Margareta Becker for taking most of the cranial measurements; and to Mrs. Dorothy Wilkinson for typing the final manuscript. Mr. Richard Archbold, of the Archbold Expeditions, the American Museum of Natural History, and the Council of the Scientific Staff of that institution, generously provided financial support for my studies in Europe.

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